XANLABS

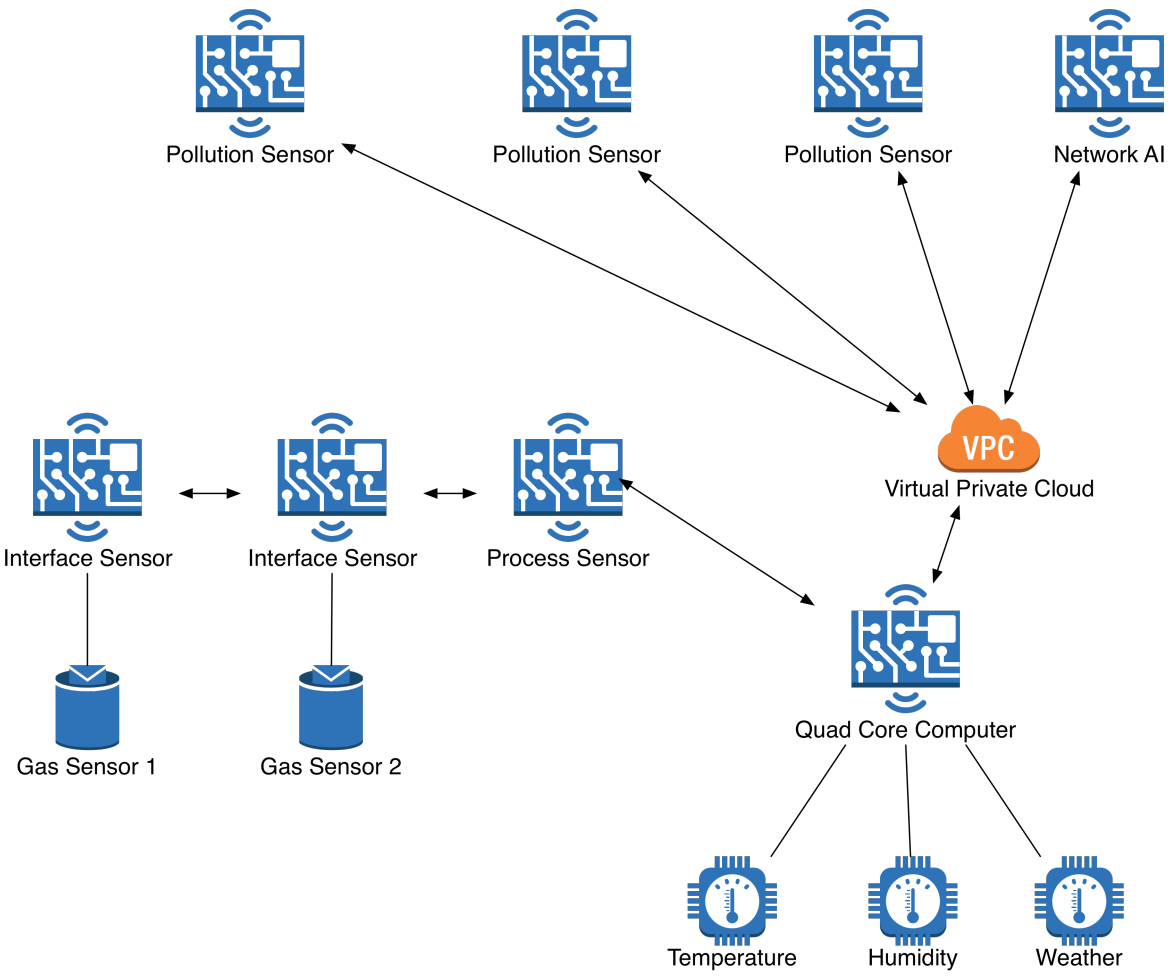
Detecting Pollution

Index

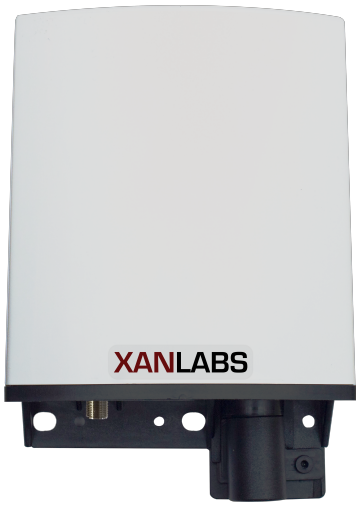
25 October 2017

XanLabs NO_2 Pollution Sensors

A hybrid sensor using digital and analogue components to make a sensor that can respond in under a minute to an increase in pollution and report it in realtime to Traffic Control systems. With optional web interface dashboard, AI predictions, graphing, and sensor cloud processing.



Sensor Technology



After two years of development, XanLabs have created a state of the art pollution monitor that uses a new generation of custom-made electrochemical sensors, and advanced digital processing to give accurate pollution readings from a compact cloud based networked sensor. This advanced sensor also filters out ozone, which is detected as NO_2 by most other sensors.

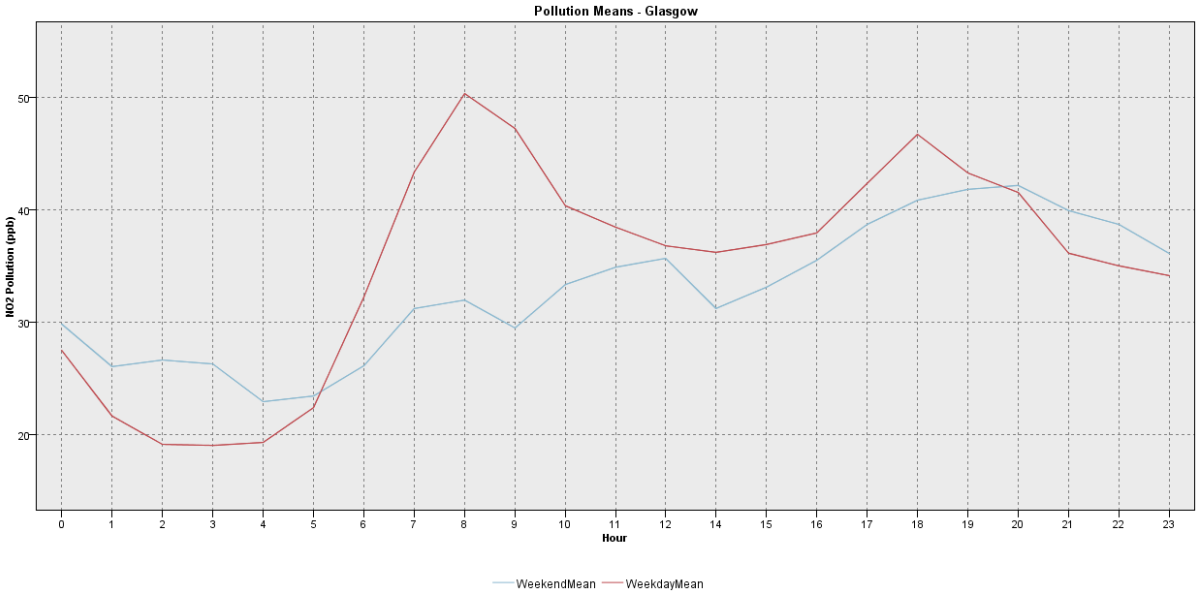
This sensor contains a powerful quad-core computer to perform advanced algorithms and digital processing to interpret data from multiple sensor inputs. The data is then sent through the network to either a central server or a cloud server that provides a clear user interface to view the data and graphing functions. Using the cloud based server provides additional options to send alerts for pollution via email and predictive alarms giving up to several hours notice of a pollution event occurring. Currently, in Glasgow, we are predicting pollution events an hour ahead with a 97% accuracy.

All data collected is stored in an SQL database that can be accessed by third party applications, and also can be exported into a variety of spreadsheet and graphing software through the straightforward web interface. The server can also be configured to automatically send any collected data to any system that follows the UTMC XML standard.

The sensor is calibrated in the factory and lasts two years before a full recalibration is needed.

The UK regulation for Air Quality Measurement is Technical Guidance TG16 section on Local Detectors (7.117), which details the use of a local detector for detailed road side real-time monitoring and local schemes. The XanLabs sensor is an ideal roadside device, priced at £1295, as when it is installed on existing infrastructure, the detector can be installed in minutes and be operational the same day.

In locations where pollution values for the Department of Environment statistics are needed then diffusion tubes can be mounted on the same pole and used to provide the Department of the Environment local air quality measurements.



This graph shows the comparison between weekend pollution, shown in blue and weekday pollution, shown in red. Weekday pollution has significant peaks around the rush hours, while weekend pollution peaks more around lunchtime and in the evening. Weekend pollution is also higher than weekday pollution only in the night and early morning hours, where the nightclubs in the area cause increased traffic relative to weekdays.

Sensor highlights

- Uses a new generation of electrochemical sensing technology, with accurate readings from 10ppb to 20000ppb (19µg/m3 to 38000 µg/m3), and a response time of under a minute.
- High capacity O3 filtering, preventing ozone from affecting sensor readings.
- This sensor is backed up by a powerful quad core computer which uses advanced algorithms to calculate an accurate NO2 reading
- Simple set up and configuration allows pollution data to be sent to a central server that provides a user interface with additional processing, graphs, and data export functionality
- This technology provides a similar accuracy to extremely expensive sensing stations, that require frequent maintenance

Comparison to other technologies

Chemiluminescence Sensors

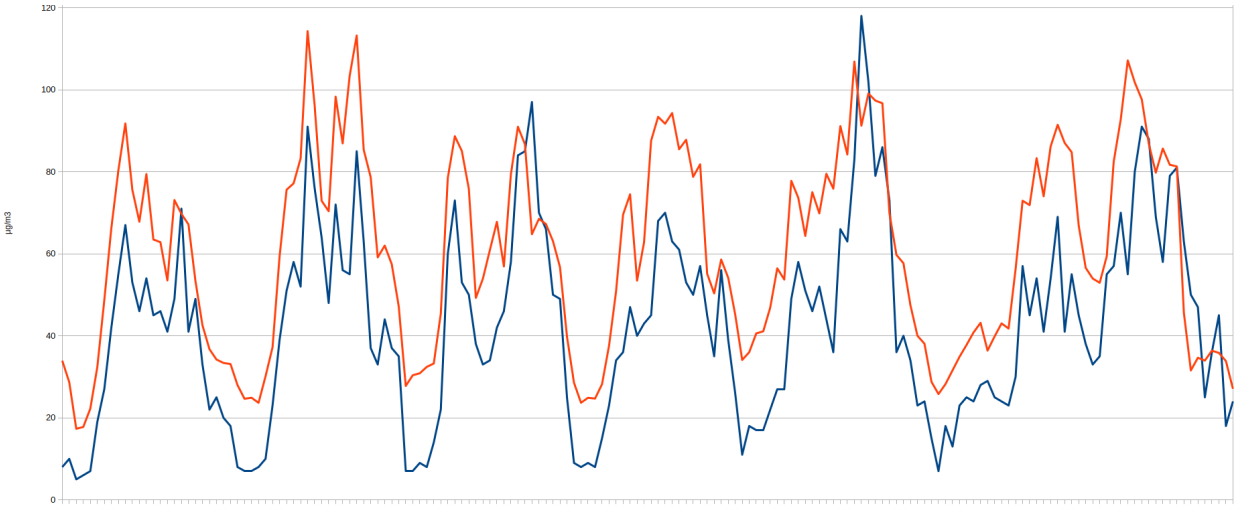
The only viable alternative technology giving realtime readings is a chemiluminescence sensor which is budgeted at around £30K to £50K and requires several square meters of road side as well as extensive civil engineering. It has to be serviced every six months by the manufacturer as a minimum, with many sensors requiring more frequent maintenance. These sensors also frequently become eyesores for the local area, getting in the way of more valuable usage of the space.

Chemiluminescence Information (Content From Government Reports)	XanLabs: Advanced Electrochemical Networked Sensor
Specified in TG16 for providing yearly statistics	Minimal data required for TG16 can be given by £10 diffusion tube on the same column.
Lower detection limit of ~ 1 µg/m^3	Accuracy drops off below detection limit of ~ 19 µg/m^3 (legal Limit 40 µg/m^3 so no real benefit to accurate lesser values)
Provides real-time data with short time resolution (<1hr) that can be used for public information	Provides realtime minute by minute results for real time traffic control
Relatively high capital cost. High operating costs.	Low capital cost allowing multiple installations
£30k to £50k	£1250 installed
Six month manufacturer maintenance minimum	2 years between calibrations.

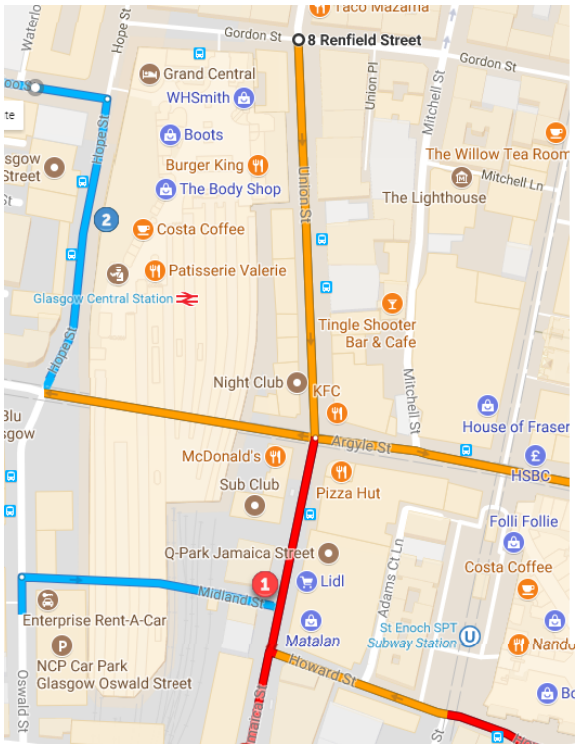
Chemiluminescence Information (Content From Government Reports)	XanLabs: Advanced Electrochemical Networked Sensor
CEN has produced a draft standard for Chemiluminescence sensors though **no** analysers commonly used in the UK have been put through a complete set of performance tests.	Low-cost sensors are expected to be added within two years. All units are calibrated in the factory unlike chemiluminescent which are calibrated on street.
The Sensor uses two chambers to measure NO2 by measuring NOx and NO and then removing NO. The means there can be a time delay whilst the first measurement is done and the second performed on a different gas sample. More Expensive units use two chambers and more complex plumbing.	Measures NO2 directly
Fixed Expensive Installations generally not on road side because of the space, but require estimation as detailed in TG16.	Possible to carry out surveys over wide geographical areas to provide information of the spatial distribution of NO2 concentrations.
Uncertainty in measurements with chemiluminescent analysers can arise from many factors relating to the instrument and to its operation and calibration.	Device can be compared to other devices by mounting a second device on the same pole or even on the chemiluminescent device and be recalibrated remotely. Currently results from XanLabs sensors track chemiluminescent sensors exactly. XanLabs sensor measures temperature, humidity plus AI tracking weather and other events.

Glasgow Pollution Sensor v Chemiluminescent

The graph below shows the readings of a XanLabs sensor compared to the readings of a nearby expensive sensing station:



The XanLabs sensor is shown in orange, while the public sensor is shown in blue.



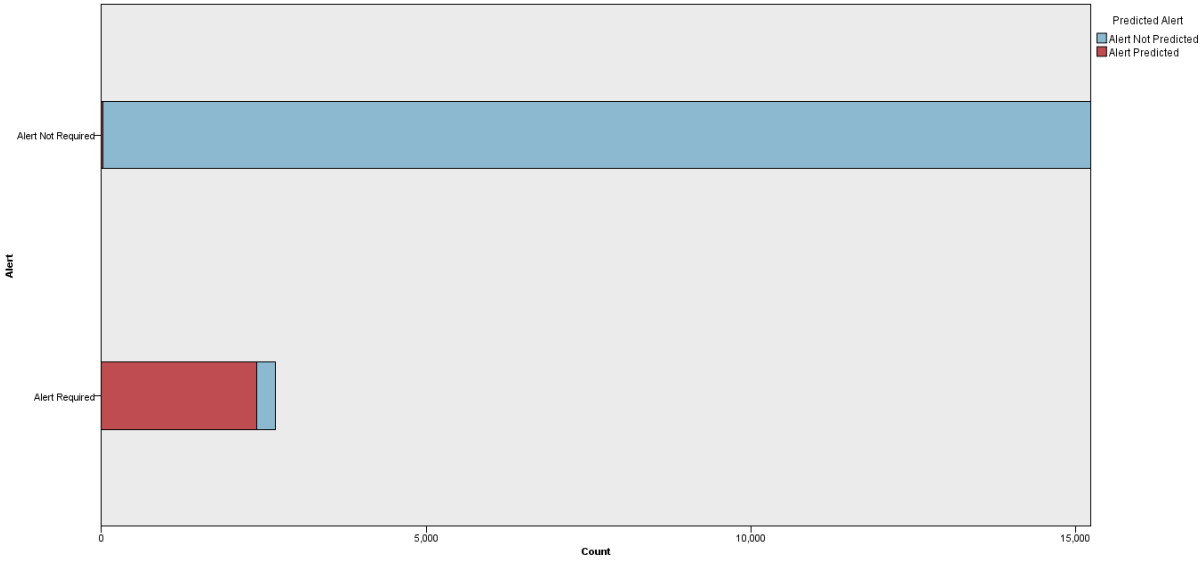
Both sensors can clearly be seen to follow the same trend, while the XanLabs sensor consistently has a higher value, this can be explained by the positioning of the 2 sensors as shown on the right. Both sensors are positioned near Glasgow Central Station, however the XanLabs sensor (1), is in a location which has significantly higher traffic flow than on the other side of the station where the chemiluminescent monitoring station is.

In addition the XanLabs sensor is outside several local nightclubs, which would result in an increased amount of traffic and pollution in the night. Also you can see in the graph that the fast response time results in the XanLabs sensor detecting a pollution peak before the chemiluminescent sensing station does.

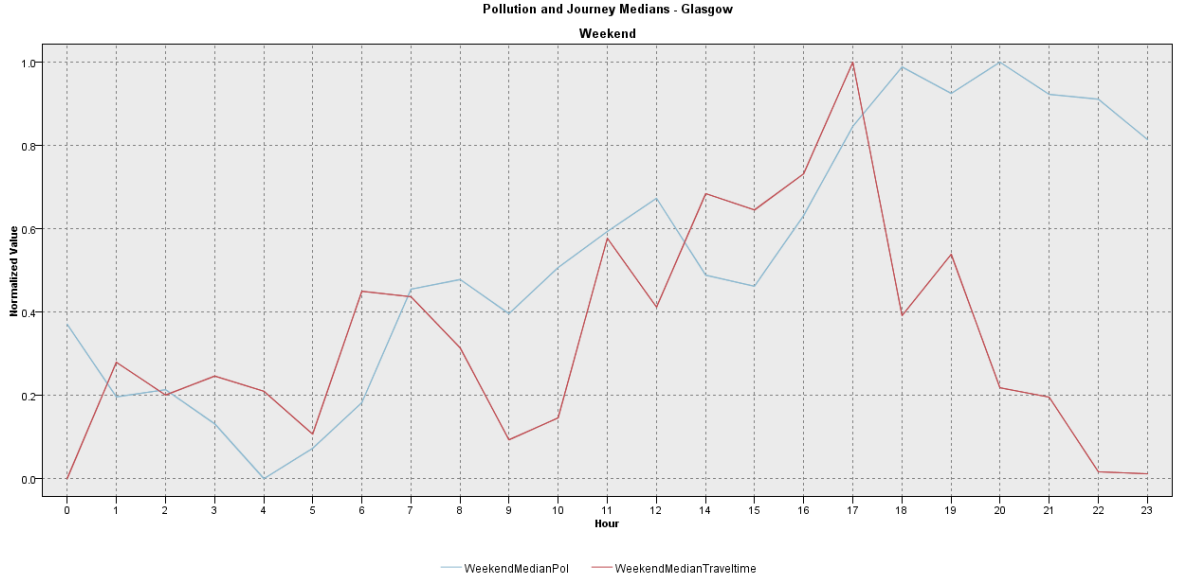
Predicting Pollution

Cloud Based AI Predictive Pollution Alerts

With the use of Bluetooth journey time sensors, a powerful artificial intelligence running in the cloud can predict a pollution event before it occurs. This predictive ability can allow pre-emptive action to be made to mitigate pollution before it rises above the limit, such as slowing incoming traffic with signal timings, or redirecting traffic using variable message signs. The AI can predict a pollution event one hour away with 97% accuracy, however it can also predict several hours ahead of time but with reduced accuracy.



This graph shows the accuracy of the AI running on testing data it has not encountered before, collected from a pollution monitor trial in Glasgow, the column marked F represents times an alert was not needed, while the column marked T represents times an alert was required. The blue colouring shows when no alert was sent, while red colouring represents an alert being sent out to take measures to reduce pollution level. The 3% error rate can be shifted to either receive more false alerts or miss more pollution events. The graph below shows one of the relationships the AI uses for its predictions, the NO_2 level (shown in blue) spikes shortly after the journey time (red) spikes.



Other Sensors

Particle Sensor

- State of the art optical sensor that detects a wide range of particles from $PM_{0.38}$ to PM_{17} including PM_{10} and $PM_{2.5}$
- Can handle up to 10,000 particles a second, with an instant response time.
- Powerful quad-core computer built into the sensor to accurately categorise each particulate that is detected by the sensor
- Simple set up and configuration allows pollution data to be sent to a central server that provides a user interface with additional processing, graphs, and data export functionality
- No recalibration, maintenance, or filter changing is required, unlike most PM monitoring solutions
- Similar price range as the NO_2 sensor and will fit of the same pole
- Imminent release with SO_2, CO, NO and O_3 will following early next year.